Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

LIBRARY
RECEIVED
★ AUG 1930 ★
U. S. Department of Agriculture

CIRCULAR NO. 130 JULY, 1930
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

TRAPS FOR THE JAPANESE BEETLE[1]

By E. R. Van Leeuwen, *Associate Entomologist*, and F. W. Metzger, *Associate Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology*

CONTENTS

	Page		Page
Introduction	1	General information concerning the use of traps	10
Value of traps	1	Description of one of the most satisfactory traps	10
Tests with traps and bait	2	Cost of traps	12
Tests with traps	2	Points worth noting in the construction of a trap	12
Bait tests in 1928	3	Bait	13
Bait tests in 1929	4	Removing beetles from traps	14
Tests with colored traps	5	Location of traps	15
The value of a sticky substance on the cylinders of traps	6	Summary	15
Results from the use of 500 traps on the grounds of Grey Towers in 1929	8		

INTRODUCTION

Since the publication of an earlier paper[2] concerning Japanese beetle traps, improvements have been made in the trap formerly recommended and in the bait employed. Traps are manufactured by many companies, and thousands were used during the summers of 1928 and 1929 in the area which is heavily infested by the beetle. The purpose of this circular is to present the new developments in trapping the beetle.

The first part contains information obtained from tests which have made it possible to recommend certain improvements in the trap and bait described in the paper referred to above, and also presents data obtained from the use of 500 traps in an area comprising 15 acres. This experimental work was carried out by the writers during the summers of 1928 and 1929.[3] An earlier publication[4] gives the results obtained from tests with traps which were conducted prior to 1928. A later section gives complete information regarding all phases of the use of traps. The recommendations presented are based on tests conducted over a period of five years.

VALUE OF TRAPS

Well-designed traps have captured large numbers of beetles, and their use for this purpose has become so popular in recent years that it appears advisable to encourage their more extensive employment.

[1] Contribution No. 71 from the Japanese beetle laboratory, Moorestown, N. J.

[2] Metzger, F. W. Information concerning Japanese beetle traps. N. J. Dept. Agr. Circ. 146, 8 p., illus. 1928.

[3] The writers express their appreciation of assistance rendered by L. B. Smith, who directed the work, and O. G. Anderson, F. E. Mehrhof, P. A. van der Meulen, N. R. Tischler, R. W. Watson, and H. Stackhouse.

[4] Richmond, E. A., and Metzger, F. W. A trap for the Japanese beetle. Jour. Econ. Ent. 22: 299–314, illus. 1929.

1344°—30

The individual use of traps in an area heavily infested by the beetle will bring about the destruction of thousands of beetles. This effort, however, unless supported by others in the vicinity, will have very little effect on the infestation in the community. It can be readily seen that, while the individual use of good traps and bait will accomplish some good, a community effort will give far broader results and is much more worth while.

The use of the traps in isolated places of infestation where there is no danger of attracting beetles from the outside reduces the local beetle population by the number captured in the traps or collected near them. This may prevent an increase or even result in a reduction in the infestation of the succeeding year.

To obtain the best results in trapping the beetle it is essential to use good judgment in the selection of traps and bait, and to follow the directions given on page 15 regarding the location and care of traps.

Traps should not be depended upon to protect plants from the attacks of the Japanese beetle, as this protection is best achieved, at the present time, by sprays applied in accordance with the recommendations of the Japanese beetle laboratory.

TESTS WITH TRAPS AND BAIT

TESTS WITH TRAPS

Previous field tests and studies have indicated quite conclusively that a relatively small number of the beetles which are attracted to the vicinity of traps are actually caught. While there is much evidence to prove that the vapor from geraniol, in proper concentrations, attracts the beetle, it apparently remains true that only one out of every three beetles attracted enters the trap. These facts show that there exists an odor which is attractive to the beetles and causes them to fly to what may be termed an attractive zone around a trap. Here the concentration of the odor is sufficiently strong to excite the beetles, but the majority do not enter the trap. Some individuals are captured, while others alight on near-by vegetation and still others leave the vicinity almost immediately. Such a condition may be caused by several factors, prominent among which are the strength of the attractive odor, location of the bait, location and size of the funnel or other entrance apertures, various climatic conditions, and the variation in the chemotropic response of individual beetles.

Because of the low efficiency of the traps in use, tests were begun in 1927 in an attempt to increase trap efficiency. The standard trap, which was employed at this time, was improved by (1) enlarging the area of the opening, (2) changing the method of dispensing the odor, (3) enlarging the trap, and (4) changing the construction of the trap.

Nearly 50 types of traps have been tested. Some of these were designed by individuals, but the great majority originated at the Japanese beetle laboratory. These traps differed widely as to size, materials used in construction, location and size of the bait container, and in many other respects. All of the traps captured

beetles, but many were unsatisfactory because of their cost, difficulty in handling, and poor construction.

Several improvements in the trap previously recommended have resulted from these tests, among which are changes in the size and construction of the baffle, color of the trap, location, size, and construction of the bait container, and various minor details.

The trap described on page 10 is of a type which has captured large numbers of beetles and is well constructed, durable, and easy to handle. The writers believe that this trap will give as satisfactory results as any other trap on the market at the present time. Work will be continued in an endeavor to improve the efficiency of traps still further.

BAIT TESTS IN 1928

The bait for traps known as the "standard bait" [5] has been used for several years and is very attractive to the Japanese beetle. It was believed, however, that a still more attractive combination could be developed. Accordingly, extensive tests with various baits were begun during the summer of 1928, and nearly 60 combinations were tested.

These tests were grouped in series. The base referred to is composed of bran, molasses, water, and glycerine in the same proportions as in the standard bait, but with no geraniol or eugenol. The arrangement of the series was as follows:

Series 1. Geraniol 1.25, 2.5, 5, 7.5, and 10 grams, with base to make 100 grams of bait in each test.

Series 2. Base 100, 200, 300, and 400 grams, geraniol 2.5 grams in each test.

Series 3. Geraniol 1.25, base 100 grams; geraniol 2.5, base 200 grams; geraniol 5, base 300 grams; geraniol 7.5, base 400 grams; geraniol 10, base 500 grams.

Series 4. Eugenol 0.06, 0.12, 0.25, 0.5, and 1 gram, geraniol 2.5 grams, and base to make 100 grams of bait in each test.

Series 5. Eugenol 0.06, 0.12, 0.25, 0.5, and 1 gram, geraniol 5 grams, and base to make 100 grams of bait in each test.

Series 6. Eugenol 0.06, 0.12, 0.25, 0.5, and 1 gram, geraniol 1.25 grams, and base to make 100 grams of bait in each test.

Series 7. Molasses 0, 10, 20, 39, and 58 cubic centimeters, with all other materials as in 100 grams of standard bait.

Series 8. Glycerine 0, 3, 6, 12, and 24 cubic centimeters, with all other materials as in 100 grams of standard bait.

Series 9. Geraniol 1.25, 2.5, 5, 7.5, and 10 grams, with 100 grams of bran only.

Series 10. Molasses only, 24 grams; molasses 30 grams and geraniol 12 cubic centimeters placed in beaker in bait container; geraniol only, 2.5 grams in beaker, area of mouth 8 square inches; geraniol only, 12 cubic centimeters in beaker, area of mouth 4 square inches; geraniol 2.5 grams, resorcin 2 grams, and bran 100 grams; geraniol 2.5 grams, eugenol 0.25 gram, and bran 100 grams.

Series 11. Bran, magnesium carbonate, kieselguhr, coarse charcoal, hydrated lime, and cotton waste 150 grams each, with rosin 2 grams (except in cotton waste), geraniol 3.75 grams, and eugenol 0.375 gram in each test.

All baits were used in each of two traps, and two traps with standard bait were run as checks in each series.

The traps were placed in a neglected peach orchard heavily infested with beetles, located near Moorestown, N. J. Each trap was

[5] The formula for approximately 100 grams of this bait is as follows: Geraniol, 2.5 grams; eugenol, 0.25 gram; bran, 50 grams; molasses, 26 cubic centimeters; glycerine, 4 cubic centimeters; water, 9 cubic centimeters.

hung from a cross arm of a standard in the middle of a square formed by four trees so that the top of the funnel was approximately 4 feet from the ground. All tall vegetation was cut down in the vicinity of each trap. Particular attention is called to the above facts because previous tests which have been conducted with traps hanging from trees have given unsatisfactory results. Trapped beetles were collected every other day, and after each collection each trap was moved to another standard according to a prearranged plan so that no one trap had an advantage over another because of its location. In order to obtain as many data as possible the position of each trap, the degree of infestation, and the degree of activity of the beetles were recorded at each collection.

It was found that the infestation was practicaly equal in all the trees of certain rows, but that it varied considerably between individual rows. For this reason, all traps of a series were placed in the same row, and as they were operating under approximately similar conditions, comparison of the various baits in a series is considered as giving an accurate indication of the relative value of the materials tested. However, on account of the variation in the infestation between rows, no comparison of results was made between the series.

RESULTS

Practically all of the combinations tested proved to be greatly inferior to the standard bait. In series 5, however, where geraniol was used at the rate of 5 grams, and eugenol in amounts of 0.06 to 1 gram, and base to make 100 grams of bait, the collections were considerably above those of the standard check. Five grams of geraniol and 0.12 gram of eugenol and the base to make 100 grams of bait gave the greatest increase over the check, the total number of beetles collected being 7,651 to 3,804 for the check, or an increase of 101.1 per cent.

BAIT TESTS IN 1929

As a result of the bait tests conducted during 1928 it was decided to continue the work, using greater concentrations of geraniol than had been employed the previous year. Four series of tests were arranged, as follows:

Series 1. Geraniol 5 grams, eugenol 0.12, 0.25, 0.50, 0.75, and 1 gram, with 100 grams of base.

Series 2. Geraniol 7.5 grams, eugenol and base as in series 1.

Series 3. Geraniol 10 grams, eugenol and base as in series 1.

Series 4. Geraniol 12.5, 15, 17.5, and 20 grams, eugenol 0.25 gram, with 100 grams of base.

The above baits were used in each of four traps, and four traps with standard bait were run as checks with each series. The traps were placed in the same orchard as in 1928, and the same procedure was followed regarding location, and the rotation of the traps following each collection. The first collection of trapped beetles was made on July 8, and the traps were withdrawn from the field on August 8.

RESULTS

Although it is impossible to compare the results between series, the relative value of the various baits may be ascertained by comparison with the standard bait which was used with each group of tests.

In Table 1 the leading bait or baits of each series, in respect to the total number of beetles captured, is compared with the corresponding check.

TABLE 1.—*Highest beetle catches from baits of each series compared with corresponding catch from standard bait, 1929*

Series	Bait	Total number of beetles collected	Percentage of increase over standard
1	Standard	12,570	
	Geraniol 5 grams, eugenol 0.75 gram	24,920	98.2
2	Standard	16,310	
	Geraniol 7.5 grams, eugenol 0.75 gram	27,050	65.8
	Geraniol 7.5 grams, eugenol 1 gram	28,880	77.1
3	Standard	16,290	
	Geraniol 10 grams, eugenol 1 gram	42,320	159.8
4	Standard	15,473	
	Geraniol 12.5 grams, eugenol 0.25 gram	28,680	85.3
	Geraniol 15 grams, eugenol 0.25 gram	29,340	89.6
	Geraniol 20 grams, eugenol 0.25 gram	31,085	100.9

The data given in Table 1 show that the bait composed of 10 grams of geraniol and 1 gram of eugenol gave the greatest increase over the standard bait, being slightly over two and one-half times as effective. The use of geraniol at the rate of 5 grams and eugenol at the rate of 0.75 gram resulted in a catch almost double that of the standard bait, while a similar figure was obtained with 20 grams of geraniol and 0.25 gram of eugenol. The results from series 4 show, however, that geraniol in amounts much greater than in the standard bait, with eugenol at the standard rate, is not as effective as when the amount of eugenol is increased in proportion to the geraniol. In other words, when the geraniol is used at a greater strength than in the standard formula, the amount of eugenol should be increased proportionally.

The use of 10 grams of geraniol and 1 gram of eugenol per 100 grams of the base will result in the bait costing a few cents more than the standard bait. The writers believe, however, that the greatly increased beetle catch resulting from the use of this new bait will more than compensate for its slightly increased cost.

TESTS WITH COLORED TRAPS

Experiments conducted during the summer of 1927 [6] showed conclusively that traps painted green captured approximately 35 per cent more beetles than galvanized-iron traps. No other comparisons of this nature were made, however, until the summer of 1929, when a thorough study was made of the relative value of colored traps.

[6] METZGER, F. W. Unpublished results.

Four traps were painted with each of the following colors: Black, blue, brown, green, indigo, purple, orange, red, white, and yellow, and four unpainted galvanized-iron traps were used as checks. These traps were located and rotated in a manner similar to that already described in the discussion of the results with various baits. The test was begun on July 6 and concluded on July 22. The results obtained are given in Table 2.

TABLE 2.—*Results of tests with colored traps, 1929*

Color of trap	Number of beetles collected from 4 traps	Percentage of number caught in green traps	Color of trap	Number of beetles collected from 4 traps	Percentage of number caught in green traps
Green	29,200		Unpainted	20,180	69.1
Brown	27,080	92.7	White	18,900	64.7
Yellow	25,990	89.0	Indigo	17,390	59.5
Red	23,730	81.2	Black	15,160	51.9
Blue	22,320	76.4	Purple	14,600	50.0
Orange	22,160	75.9			

The results given in Table 2 show that traps painted green captured more beetles than traps which were painted the other colors mentioned. The difference between the green, brown, and yellow traps is not great, and it will probably be necessary to conduct further tests to finally establish the superiority of green traps over those painted yellow or brown. At present, however, green-colored traps appear to be the most satisfactory.

THE VALUE OF A STICKY SUBSTANCE ON THE CYLINDERS OF TRAPS

During the summer of 1927 a few preliminary tests [7] showed that a sticky substance on paper placed around the cylinders of traps caught as many beetles as were captured in the traps. The beetles which alighted on the paper were able to extricate themselves in a few minutes, but during this period they had become so covered with the sticky material that many died within a few hours, and none was observed to fly. As most of the beetles soon dropped from the paper the surface did not become covered with the insects, and ample room remained for new arrivals to alight. The sticky material may be prepared by heating 5 pounds of rosin and 3 pints of castor oil until the rosin is melted and then smearing the liquid liberally on heavy wrapping paper.

In 1929 these tests were repeated on a larger scale by placing sticky material on several traps and suspending each trap from the cross-arm of a standard. A tub partly filled with water was placed under each trap to catch the insects falling from the trap so that an accurate count could be made of all beetles which came in contact with the sticky substance. A trap without any of the sticky material served as a check and was also suspended from another standard driven into the ground at the side of the one bearing the sticky trap. The cross-arms of the standards formed a straight line, and

[7] METZGER, F. W. Unpublished results.

the traps were approximately 4 feet apart. (Fig. 1.) The traps were placed in the field on August 10, and the last collection was made on August 26. A summary of the results is given in Table 3.

The two traps at each station were obviously located under similar conditions, and each one doubtless exerted some influence on the other. If two traps are located in exactly the same environment such reciprocal influence can not be avoided, and the writers do not believe that the results were markedly affected by it.

FIGURE 1.—Arrangement of treated and check traps in the tests with a sticky substance on the trap cylinder, in 1929. The treated trap is on the left

TABLE 3.—*Number of Japanese beetles collected by the use of traps covered with a sticky substance, 1929*

Station	Beetles collected at sticky trap			Beetles collected at check trap		
	Trap	Tub	Total	Trap	Tub	Total
1	1,279	2,105	3,384	1,830	84	1,914
2	1,433	2,182	3,615	1,970	74	2,044
3	1,269	2,218	3,487	2,886	177	3,063
4	1,541	2,633	4,174	2,503	83	2,586
5	1,473	2,177	3,650	1,859	82	1,941
6	1,800	3,347	5,147	2,558	87	2,645
Total	8,795	14,662	23,457	13,606	587	14,193

The total number of beetles taken from the sticky traps and the tubs underneath was 23,457 and that from the check traps and tubs was but 14,193, a difference of 9,264 in favor of the former. The check traps, however, captured 13,606 beetles, while the treated traps captured only 8,795. This indicates that many of the beetles which hit the sticky sides of the traps and then fell into the tubs would doubtless have eventually been caught in the traps themselves if the sticky material had not been present. On the other hand, the 14,662 beetles taken from the tubs under the treated traps and the 587 from the check tubs prove definitely that many more beetles were caught by the sticky material alone than were caught in the check traps.

The results of these tests show that the use of the sticky substance on trap cylinders results in fewer beetles being caught in the traps,

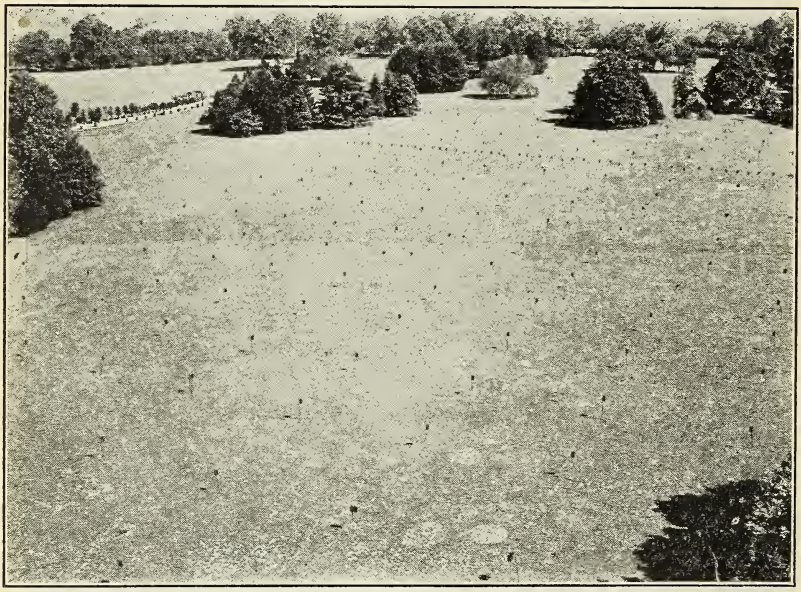

FIGURE 2.—Section of the grounds of Grey Towers, Beaver College, Pa., showing some of the 500 traps in operation. The row of traps 6 feet apart may be seen in the background

but that it greatly increases their efficiency, since the treated traps caught an average of 65 per cent more beetles than were caught in the untreated traps.

RESULTS FROM THE USE OF 500 TRAPS ON THE GROUNDS OF GREY TOWERS IN 1929

Five hundred traps of the type described on page 10 were distributed over an area of 15 acres on the grounds of Grey Towers, a part of Beaver College,[8] located near Jenkintown, Pa. Wherever possible the traps were placed in rows approximately 30 feet apart with 30 feet between the traps in each row. (Fig. 2.) At one point,

[8] The writers wish to express their appreciation of the valued cooperation and the many courtesies extended by the officials of Beaver College.

as also shown in Figure 2, a number of traps were placed in a single row only 6 feet apart. The traps were put into operation on July 10 and were withdrawn on August 23. The bait in all traps was changed on August 1. During this period 1,876 pounds of beetles were collected from the trap jars. It has been found that a pound of beetles averages 4,800 individuals, and, on this basis, 9,004,800 beetles were captured and destroyed. (Fig. 3.) It was impossible to place the traps in position before July 10, and the beetles were already present in large numbers at this date. Moreover, during the first few days after the traps had been placed in operation, it was impossible with the labor available to collect the beetles fast enough to keep the containers empty, and thousands of beetles escaped. Had it been possible to start the test earlier and keep the containers empty, the final total would have been much larger.

FIGURE 3.—Total catch of beetles from the 500 traps at Grey Towers, 1929

Captured beetles were examined on several occasions during the summer to determine the ratio between the sexes. Of the 3,026 beetles which were examined, 1,506 were females and 1,520 were males, which indicates that both sexes were captured in approximately equal proportions.

During September a survey was made of the soil to determine the grub population in the area where the traps were located. A summary of this survey is as follows:

Square yards of soil examined (1 square yard at each digging), 38.
Total number of grubs found, 8,586.
Average number of grubs per square yard, 225.9.
Maximum number of grubs per square yard, 675.
Minimum number of grubs per square yard, 0.

It was estimated that approximately 13,000,000 grubs were in the area covered by the traps. The ground was treated with lead arsenate according to the recommendations of the Japanese beetle laboratory, and the results from previous tests indicate that a very high percentage of grub mortality will result from this treatment.

In the area where the traps were located there were very few trees which are normally subject to beetle injury. It is, therefore, impossible to state how much damage the great concentration of beetles would have caused to foliage had there been more trees which are usually attacked by the beetle.

No accurate estimate can be made as to how far the beetles were attracted to the traps, but it appears evident that such a large number must have been drawn from a considerable part of the surrounding territory.

It is difficult to draw conclusions from the results of this experiment. A large number of beetles were captured by the traps and killed, and the lead-arsenate soil treatment killed thousands of the grubs which had hatched from the eggs deposited by female beetles attracted to the vicinity by the traps. Further work must be done at this same locality for one or more years before the exact value of the use of traps as a means of permanently reducing the beetle population of a given locality can be determined.

GENERAL INFORMATION CONCERNING THE USE OF TRAPS

DESCRIPTION OF ONE OF THE MOST SATISFACTORY TRAPS

A description of one of the most satisfactory traps (fig. 4) in general use at the present time follows. This type of trap, with the exception of a few minor details, was developed at the Japanese beetle laboratory. Figure 5 shows a cross section of the trap with dimensions, and Figure 6 illustrates an unassembled trap. All exterior parts are painted chrome green.

CYLINDER

The cylinder is constructed of 30-gage galvanized iron and is 7 inches high, with a diameter of 7 inches. The sides are pierced by six holes three-sixteenths of an inch in diameter, 1 inch from the top and equidistant. The bottom also has six $\frac{3}{16}$-inch holes which are equidistant and 1 inch from the outer wall. The screw top of a standard mason jar which forms part of the bottom is $2\frac{3}{4}$ inches wide and projects five-eighths of an inch into the cylinder. A hole, 2 inches in diameter, is punched in the center of this top. Two handle brackets are located one-fourth of an inch from the top of the cylinder. The handle extends $7\frac{1}{4}$ inches above the upper rim. This measurement includes a $\frac{3}{4}$-inch loop in the handle to facilitate suspension from a hook. The top edge of the cylinder is curved outward.

FUNNEL AND BAFFLE

The funnel and baffle are also constructed of 30-gage galvanized iron. The funnel is $7\frac{1}{4}$ inches in diameter at the top, three-fourths of an inch at the bottom, and is $7\frac{1}{2}$ inches deep. Its upper edge is

curled to fit snugly over the top of the cylinder. The baffle is 7¼ inches wide and 4 inches high. It is formed by two pieces of material fitted at right angles and soldered to the top of the funnel. The edges of the baffle are turned to avoid the danger of the operator being cut while handling the trap.

BAIT CONTAINER

The bait container is constructed of lacquered 30-gage block tin. It is 6⅞ inches in diameter and should slide freely in and out of the cylinder. The outer collar is 1¾ inches high, and the inner collar, which has a diameter of 3 inches, is of the same height. Both collars are soldered to the bottom of the container. The bottom is perforated by holes one-sixteenth of an inch in diameter and has a 2-inch hole punched in its center.

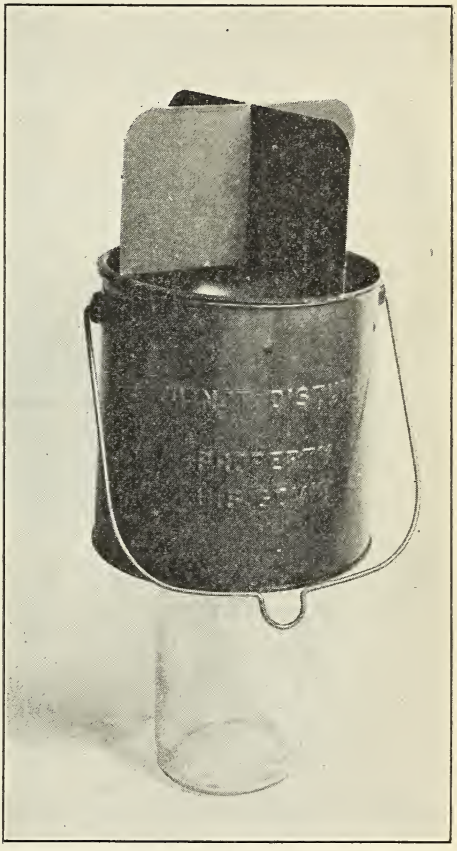

FIGURE 4.—Assembled Japanese-beetle trap with jar attached

DRAINAGE OUTLET IN BEETLE CONTAINERS

Jar beetle containers should have a small perforation in the bottom to permit the escape of water, otherwise they will soon become filled during a period of wet weather. A commercial glass company has undertaken to place such jars on the market, and a number of dealers will doubtless equip their traps with them.

A process of making an outlet in the bottom of a glass jar has also been developed at the Japanese beetle laboratory.[9] By this method a slit is made in the jar by an abrasive wheel one-sixteenth of an inch thick and running at a high rate of speed. The particular type of wheel used is known as a 60-grain, 6-inch, electrolon wheel. It cuts best when running at a speed of 10,000 linear feet per minute. When a jar is held with its bottom edge against the wheel, with moderate pressure, sufficient heat is developed to crack the glass. This difficulty was overcome by playing a stream of water over the point where the cut was being made. When

[9] This process was devised by P. A. van der Meulen, Agent, Bureau of Entomology, U. S. Department of Agriculture.

the stream is properly directed and the jar is held against the wheel with moderate pressure, a slit can be cut in a few seconds, and the loss due to breakage is negligible.

COST OF TRAPS

While the trap described above is believed to be the most satisfactory type in general use at the present time, there are many other traps available which will capture beetles in considerable numbers. The retail price of traps varies considerably and depends chiefly upon the size of the trap and the kind of material used in its construction. The smallest traps sell for 10 cents, and the prices range up to $2.50 for the more expensive types. With reasonable care a substantially made trap will last for several years, and a number which have been employed at the Japanese beetle laboratory for five summers are apparently as good as new. Traps are on sale at practically all hardware and seed establishments in New Jersey and eastern Pennsylvania. They are also carried by a number of the larger department stores.

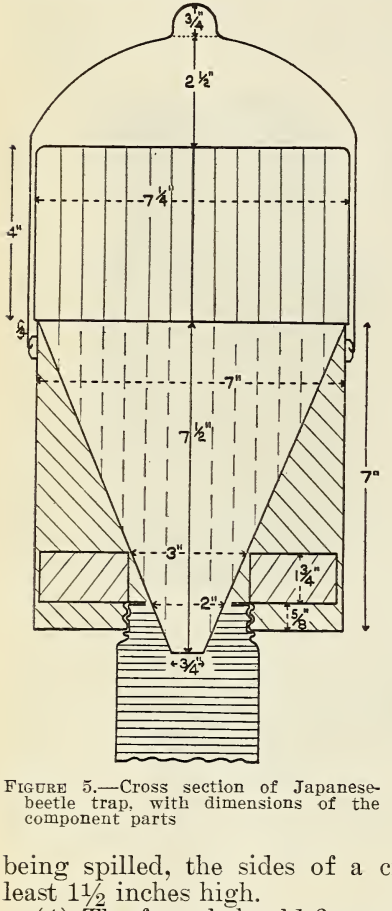

FIGURE 5.—Cross section of Japanese-beetle trap, with dimensions of the component parts

POINTS WORTH NOTING IN THE CONSTRUCTION OF A TRAP

(1) A trap constructed throughout of galvanized iron is much more durable than one made of tin and is, therefore, worth more.

(2) In cylindrical traps the bait container should be rigid and should slide in and out of the trap cylinder without binding. This is very important, as a bait container that binds is certain to be difficult to manipulate.

(3) To prevent the bait from being spilled, the sides of a circular bait container should be at least 1½ inches high.

(4) The funnel should fit snugly over the top of the trap cylinder.

(5) Baffles, consisting of two pieces of material fitted together at right angles, are more satisfactory than a single piece of metal attached to the top of the funnel.

(6) Traps painted green will catch more beetles than will traps painted any other color.

(7) Traps which have funnels of paraffined cardboard are unsatisfactory, as a single rain will render them unfit for further use.

BAIT

Beetles are drawn to traps because the geraniol and eugenol which are present in the bait are attractive to them. The Japanese beetle laboratory has tested a great many substances as attrahents for the beetle, but up to the present time none have been found to be as attractive as a combination of the two materials mentioned above. Geraniol should not be confused with geranium oil, as the two substances are entirely different compounds, and the geranium oil is considerably less attractive to the beetles than is geraniol.

Under ordinary conditions, one baiting of a trap is good for three weeks. If the bait becomes moldy because of excessive moisture, it should be changed at once, and if part is spilled an amount equal to that lost should be added. Traps are rarely in use for more than six to eight weeks during the summer, and two or three changes of bait are usually sufficient.

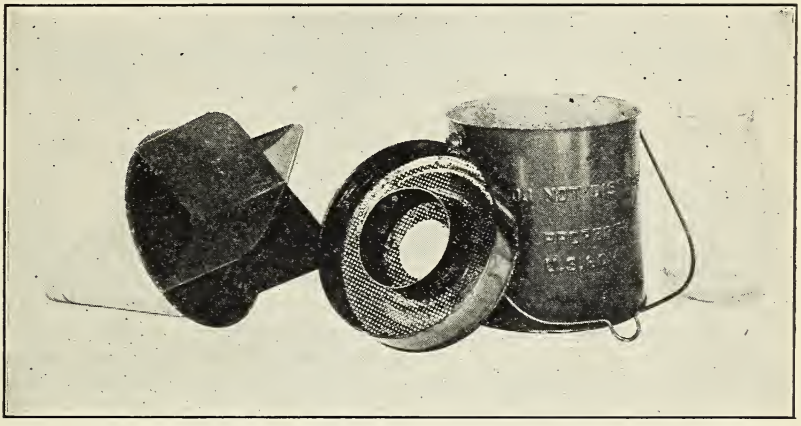

FIGURE 6.—Unassembled parts of the Japanese-beetle trap

The following formula is now recommended for one baiting of the type of trap described. It will be noted that the only change from the former recommendation is that the quantities of geraniol and eugenol have been increased on the basis of the results obtained from experiments described in the first part of this circular.

Formula for one baiting of the trap described

Geraniol (at least 58 per cent pure).	15 grams (4 teaspoonfuls).
Eugenol (U. S. P.)	1.5 grams (¼ teaspoonful).
Bran	75 grams (1½ cups).
Water	13 cubic centimeters (1 tablespoonful).
Molasses	39 cubic centimeters (2½ tablespoonfuls).
Glycerine (chemically pure).	6 cubic centimeters (1½ teaspoonfuls).

Total weight, approximately 150 grams, or one-third of a pound.

Certain types of traps have containers which hold only from 10 to 25 grams of bait. When bait prepared according to the above formula is used in such traps, it will be seen that only a very small

quantity of geraniol and eugenol is present. This quantity of bait does attract beetles. The efficacy of traps with small bait containers is greatly increased, however, by adding as much geraniol and eugenol to 25 grams of the plain bait as is recommended for the larger quantity.

Bait prepared according to the earlier formula has been made by a number of companies and individuals, and it is expected that bait prepared by the new formula will be on the market during the summer of 1930. The bait is usually sold in cans of various sizes, and many dealers provide sufficient material for one baiting with each trap. The use of bait in the heavily infested beetle area has become so widespread during the past two years that bait can be obtained readily, since many classes of stores handle it. Material for one baiting of the trap described in this circular usually retails for from 40 to 75 cents.

Some people prefer to make their own bait, and directions for its preparation are as follows:

First add the water and glycerine to the molasses and shake vigorously. Then pour the liquid into the bran, stirring constantly. Add the geraniol and eugenol, and stir until the bran is thoroughly mixed with the liquid.

Bait should be kept in a closed container and stored in a room free from dampness until used. It is obvious that the labor required to prepare the bait for a number of traps is but little greater than that required to prepare it for one.

When several traps are operated at one time, the bait materials may be purchased in quantity, with consequent saving. When the bait ingredients are purchased wholesale the cost of baiting a single trap is about 3 or 4 cents. The retail prices of the materials vary considerably, and when the ingredients are purchased in this manner one baiting for a single trap will cost approximately 15 to 20 cents. All materials which comprise the bait are readily obtainable with the exception of geraniol and eugenol, which can usually be purchased at chemical-supply houses. Various grades of geraniol are on the market, and one of not less than 58 per cent purity should be used.

REMOVING BEETLES FROM TRAPS

As beetles are very active during the day, it is best to remove them from a trap after 7 p. m. or before 8 a. m. because between these hours they seldom fly and very few are likely to escape. However, it is much easier to collect beetles in the daytime from traps with jar beetle containers than from traps where the funnel and bait container have to be removed to perform this operation.

In collecting beetles from a trap with a jar container, simply unscrew the jar and quickly empty it into a pail which contains water and a small quantity of gasoline or kerosene, or very hot water alone. This will kill the beetles in a short time. If the beetles from several traps have been emptied into a pail, the mass should be stirred to insure the wetting of all the beetles. The container should be kept covered until the insects are dead. A trap which is not equipped with a jar container is best emptied by placing the trap on the ground and then removing the funnel and bait container. The

beetles may then be emptied into a pail. This operation is greatly facilitated by striking the sides and bottom of the cylinder.

Each trap should be emptied at least every other day to avoid decomposition of the insects. When jars are employed which have no outlet in the bottom, it is also necessary to empty them after a rain, as considerable water will collect in them. The jars should also be washed occasionally because they soon become dirty from beetle excrement. Care must be taken to keep the trap and jar free from any odor save that of the bait, otherwise the beetle catch will be greatly diminished.

After beetles have been killed they should be disposed of as soon as possible. Whenever it is possible, burying seems to be a most satisfactory means of disposal. Burning, even with the aid of oil or kerosene, does not entirely consume a considerable quantity of beetles, and the combustion is accompanied by a disagreeable odor. If the beetles are to be disposed of with trash they should be placed in a closed container unless they are carried away within a few hours after they have been killed. Beetles killed with hot water have been fed to chickens with no apparent ill effects, but the Japanese beetle laboratory has made no attempt to determine the value of dead beetles as food for poultry.

LOCATION OF TRAPS

When traps are suspended in trees the beetles that are attracted but not caught usually cause severe injury to the foliage by their feeding. It is, therefore, much better to place a trap 10 to 15 feet away from any foliage. When located in this manner, the trap tends to draw the beetles away from trees or shrubbery. Traps should not be placed on the ground, but should be suspended from a post or standard so that the top of the funnel is at a height of 3 to 4 feet. A wooden standard should be equipped with a short arm, or a steel standard should be bent so that the trap will hang free and the beetles will not be blocked off on one side by the post. Suitable standards are usually sold by the dealers who handle traps. The beetle is extremely fond of sunlight and will rarely enter a trap in the shade. For this reason the traps should be located so that they are in the direct light of the sun for as many hours as possible.

Seasonal variation makes it impossible to set a definite date for placing traps in the field or removing them at the end of the summer. During the past five years they have been used effectively between June 25 and September 1 in the vicinity of Philadelphia. The best rule to follow is to place traps at the desired position as soon as beetles appear and to allow them to remain as long as the insects are present.

SUMMARY

The use of traps is an effective and inexpensive means of capturing large numbers of Japanese beetles.

Traps are not recommended to protect fruit, flowers, or foliage from the attacks of the beetle.

Nearly 50 types of experimental traps have been tested in an attempt to improve the efficiency of traps in general, and several improvements have been made in the type previously recommended.

Geraniol at the rate of 10 grams with eugenol at the rate of 1 gram to 100 grams of bran, molasses, glycerine, and water base form the most attractive bait combination for use in traps at the present time.

Traps painted green captured more beetles than those of any other color used. Brown and yellow traps were, however, approximately 90 per cent as efficient as the green ones.

The use of sticky paper on the cylinders of traps greatly increases their efficacy.

Over 9,000,000 beetles were destroyed by the use of 500 traps on a 15-acre tract during the summer of 1929.

A description is given of a trap which is satisfactory in every respect. General information is included regarding the preparation of bait and the care and proper location of traps.

U. S. GOVERNMENT PRINTING OFFICE: 1930

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents